NGSS Alignment to Pathways of Sustainability: HS-ESS2

The National Wildlife Federation's Eco-Schools USA program has aligned their program Pathways of Sustainability to the Next Generation Sciecne Standards, NGSS. As a part of the Eco-Schools 7-Step Framework, linking to the curriculum is a priority. **This alingment is designed to highlight the natural connections between the NGSS and NWF's Eco-Schools USA program.**

Our program icons are used to denote pathway connections the NGSS Performance Expectations**. Not every topic, with its set of Performant Expectations are a fit with NWF's Eco-Schools USA program and in that case an alignment will not be present.**

Also present within this alignment document are connections to the **Common Core State Standards, CCSS, English Language Arts, ELA and Mathematics, 21st Century Skills, Environmental Ladder of Responsibility, and Connections to Music, Physical Education, and Art.**

Green STEM is an initiative of NWF's Eco-Schools USA program and is focused on identifying best practice in the STEM fields as it relates to environment-based learning. These elements include:

- Problem-Based Learning
- Utilizing the school, both inside and outside, as a learning laboratory
- The incorporation of two or more STEM disciplines within a single lesson, whole curricula, a set of standards, etc.
- A Maker mentality – design/create/solve
- A commitment to service learning
- An inclusive culture, where all students can learn and all student can participate

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HS-ESS2 Earth's Systems

Students who demonstrate understanding can:

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

Science and Engineering Practices

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6)
- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS- ESS2-4)

Disciplinary Core Ideas

ESS1.B: Earth and the Solar System

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2),(HS-ESS2-4)
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4)

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4)

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2- 2)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS2-2)

Connections to other DCIs in this grade-band: **HS.PS1.A** (HS-ESS2-6); **HS.PS1.B** (HS-ESS2-6); **HS.PS3.A** (HS-ESS2- 4); **HS.PS3.B** (HS-ESS2-2), (HS-ESS2-4); **HS.PS3.D** (HS-ESS2-6); **HS.PS4.B** (HS-ESS2-2); **HS.LS1.C** (HS-ESS2-6); **HS.LS2.B** (HS-ESS2-2),(HS-ESS2-6); **HS.LS2.C** (HS-ESS2-2),(HS-ESS2-4); **HS.LS4.D** (HS-ESS2-2); **HS.ESS1.C** (HS-ESS2-4); **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **HS.ESS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)

Articulation across grade-bands: **MS.PS1.A** (HS-ESS2-6); **MS.PS3.A** (HS-ESS2-4); **MS.PS3.B** (HS-ESS2-4); **MS.PS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.PS4.B** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.LS1.C** (HS-ESS2-4); **MS.LS2.B** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.LS2.C** (HS-ESS2-2),(HS-ESS2-4); **MS.LS4.C** (HS-ESS2-2); **MS.ESS2.A** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.ESS2.B** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.ESS2.C** (HS-ESS2-2),(HS-ESS2-4); **MS.ESS2.D** (HS-ESS2-2),(HS-ESS2-4); **MS.ESS3.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.ESS3.D** (HS-ESS2-2),(HS- ESS2-4),(HS-ESS2-6)

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Common Core State Standards Connections:

ELA/Literacy –

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS2-2)
RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2)
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-4)

Mathematics –

MP.2	Reason abstractly and quantitatively. (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)
MP.4	Model with mathematics. (HS-ESS2-4),(HS-ESS2-6)
HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-4),(HS-ESS2-6)
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)

climate change energy

ECO-SCHOOLS USA PATHWAYS ALIGNMENT

HS-ESS2, HS-ESS-4, HS-ESS-6

Each *Performance Expectation* is more successfully accomplished by students who have spent significant time outdoors in the natural world. Connecting to nature increases student engagement, focus, creativity and innovation. Connecting to nature also builds an appreciation and respect for the community, state, country, and world we live in. This appreciation and respect allows students to better understand the impacts of climate change on our built and natural systems. Engaging students in the Energy and Climate Change Pathways provides students with age appropriate knowledge and tools allowing them to make meaningful change in their community while increasing their understanding of the fact-based science related to climate change, such as the flow of energy through Earth's systems and associated feedbacks due to changes over time. Ultimately, we want students to feel they have the confidence and resources to change or mitigate the negative impacts on wildlife and wild places.

LADDER OF ENVIRONMENTAL RESPONSIBILITY

Looking at the responsibilities below determine which are applicable or could be modified to add rigor and more meaning to student studies in climate change.

Green Living Pledge

- Each grade level has a goal to meet (reducing the overall carbon footprint, reduction in kilowatt hours, amount of recycling, conservation hours, etc.)

Social Contract Theory

- Students explore different ethical dilemmas related to the environment and to global social, economic, and political discussions and quandaries
- Students explore ethical theories and relate to past and present case studies involving social contract theory and the environment

Connecting with the County – Student Liaison

- Dept. of Facilities and Transportation Services: Student Liaison to report back on district programs; re: Energy Management Program, Greenhouse Gas Inventory, Municipal Separate Storm Sewer System (MS4) Program, and Recycling Program

Connecting to Home, Work, and Community

- Fostering new and continued Business and Community Partnerships

Using Tools Outside

- What tools we use; using tools properly and safely; return tools; using more technology as a tool to record, analyze, and share data.

Caring for our Environment

- We have to care for our environment as we have a shared global interest in stewardship for the Earth and its resources.

The Three R's

- Try to reuse what you can; recycle what you can't. Conservation and reducing waste and water/energy use.

21st CENTURY SKILLS

Learning and Innovation

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication and Collaboration

Information, Media, and Technology

- Information Literacy
- ICT (Information, Communications and Technology) Literacy

Life and Career

- Flexibility and Adaptability
- Initiative and Self-Direction
- Social and Cross Cultural Skills
- Productivity and Accountability
- Leadership and Responsibility

Music/PE/Art

Work with teachers on campus that have the ability and expertise to extend student learning beyond their core academic classes, ELA, science, math, and the social studies. Examples include:

- Have students research folk singers and the music written in response to crimes against nature. Students could provide instrumental covers or covers of those pieces and/or originals works for an Earth Day celebration.
- Advocate for more unstructured natural physical education – free choice connections to nature – What types of programs could athletes prepare and carry for students in their feed middle and elementary schools?
- Artists around the world have used their talents to inspire change in their community and around the world. Ask the art teacher to provide students with an opportunity to do research on the topic and then use their artistic talents to inspire change in their community.